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ABSTRACT

The First Global Recession in Decades*

I use monthly data on industrial production to estimate the distribution of international business cycle correlations since the 1980's, with focus on the current turmoil. The degree of international correlation in national business cycles since the end of 2008 is unprecedented in three decades. From 2008M12, an upward shift in the cross-sectional distribution of cycles synchronization is sizeable and significant, especially between advanced economies. The magnitude of the shift is unprecedented in recent history, even relative to what happened since 1973 after alternative shocks with worldwide consequences. The shift does not arise because volatilities changed with the crisis. Both goods and assets trade have contributed to this synchronization. The (large and significant) synchronization amongst OECD economies is associated with financial openness. The (weaker) diffusion amongst developing economies tends to happen between trade partners.

JEL Classification: E32, F15, F36 and F41
Keywords: financial linkages, international business cycle, sub-prime crisis and trade linkages

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1 Introduction

The current turmoil is often argued to have had unprecedented global consequences. According to virtually any definition, most countries have entered recession since late 2008. Perhaps more than the severity of the recession, it is the universal consequences of a US-based shock that has drawn comparisons with the Great Depression. In this paper, I investigate rigorously the global nature of the sub-prime crisis. I estimate the cross-sectional distribution of bilateral cycle correlations $\rho_{i,j}$ for a large sample of country-pairs i, j, including both rich and developing economies. I consider how the distribution has evolved over time, with focus on sub-periods characterized by "global" shocks. I contrast what has happened since the late 2000's with prominent instances of worldwide crises since 1973. The experiment is performed holding constant the volatility of GDP growth at pre-crisis level. Thus the focus is squarely on a putative shift in the international channel of shock diffusion since 2008.

As the sub-prime crisis unraveled, both goods and assets trade retreated, or at least relocated. It is an open question whether the change was a consequence of the crisis, or did actively contribute to its diffusion. World trade can fall as a result of the collapse in economic activity, and international capital be withdrawn because recessions are a bad time to invest. Still, international financial linkages are often accused of having channeled the international diffusion of the shock. Capital is repatriated as financial intermediaries "de-leverage" their balance sheets, and, perhaps, export the crisis to borrowing, developing economies.

The paper proposes to examine the joint dynamics of bilateral cycle correlations, and the observed changes in goods and financial trade. Crucially, no causal inference is sought, as both types of trade have presumably responded to the onset of the crisis. Time varying instruments for goods and assets trade are simply not available, especially for the type of country and time coverage proposed in this paper. Rather, the approach is akin to an analysis of variance: What fraction of the change in cycle correlation observed around the sub-prime crisis can be explained by changes in goods and assets trade? And is one channel more important for developed or developing economies?

The current episode informs the extensive literature on international business cycles in a number of useful ways. First, the unprecedented shift in the world business cycle represents an opportunity to study time-changes in cycles synchronization. As Doyle and Faust (2005) have forcefully argued, up until this episode significant shifts in the distribution of bilateral cycle correlations were virtually absent from the data. The distribution had been too persistent, and measured too imprecisely, for any observable variable to cause significant time changes. The current episode opens the door for a panel analysis of the determinants of business cycle synchronization - as opposed to conventional cross-sectional estimates. Second, the shock initiating the crisis is arguably exogenous to developments

in most of the rest of the world, and clearly has its roots in the U.S. Thus, recent data illuminate how country-specific shocks (or at least the sub-prime event) tend to diffuse internationally. The current episode is presumably the result of a US-based shock diffusing internationally. It provides a natural experiment in which to analyze the international channels of diffusion, at least of the sub-prime shock. It helps draw some inferences that may improve the modelling of the international business cycle. For instance, Kose and Yi (2006) argue the estimated elasticity of comovements to bilateral trade intensity is difficult to rationalize in a conventional trade model, a "trade-comovement" puzzle. But the estimated trade-comovement elasticity could take high values because the data reflect shocks that are correlated internationally, which obscures the theoretical intepretation of elasticity estimates. In short, the current turmoil provides a laboratory likely to sharpen the empirical testing of the modelling of the international diffusion of shocks.

The main results are as follows. There is overwhelming evidence world cycles have become significantly more synchronized with the crisis, relative to their level since the 1980's. The distribution of bilateral correlations has observably shifted upwards for data ranges that include the last few months of 2008, and thereafter. In fact, a significant shift in the distribution occurs when 2009M1 and the months that follow are included in the computation of correlations. The shift is significantly larger now than after any of the prominent instances of world shocks since the 1970's, with the possible exception of the 1973 oil shock. The current distribution has higher first moments and skewness than estimates computed immediately after the Savings and Loans crisis, the October 1987 crash, the Nikkei crash, the European Exchange Rate Mechanism crisis, LTCM collapse, the Nasdaq crash, or the U.S. bankruptcies of 2002. In fact, there is no other period in the data available since 1980 that displays a similarly significant shift in the distribution of cycles synchronization. In that sense, the current turmoil is indeed the first global recession in decades.

The increase in cycles correlation is particularly pronounced for rich OECD countries. It is at best weakly significant for cycle correlations between developing economies, or between OECD and non OECD countries. The data point to a shock that has diffused first and foremost between developed economies, while the developing world has remained relatively insulated. Including data until the end of 2008, the mode of the distribution of bilateral correlations is weakly significantly positive for developing economies. In the rich world, it stands above 0.8. Yet there were no observable differences across the two samples prior to 2008. There seems to be a specificity to the diffusion mechanism that exists between rich countries. At the very least, the shock has diffused slowly to the developing world, where cycles correlations have remained sizeably lower. They continue to do so, even with data running until May 2009.

The last section of the paper seeks to account for this difference across samples. I consider two conventional determinants of business cycle correlations, or particular relevance

in the current context. I compute the intensity of bilateral trade, and a measure of mutual openness to financial flows. Both measures vary over time, and the paper relates these dynamics with the changes in the cross-sectional distribution of cycle synchronization. The measures are scale independent and capture the reallocation of trade across partner countries. Goods or assets trades are normalized by their total value across countries. The variables capture reallocation effects, as changes in goods or financial trade that happen to an unequal extent across partner countries affect its cross-section.

Both before and after the crisis, the correlates of $\rho_{i,j}$ are conventional. Rich countries are synchronized, even more so if they are trade partners. Financial openness also drives synchronization up, albeit less significantly. This happens both in rich countries, and (albeit more weakly) in developing economies. The results are in line with the basic findings from a large literature, for instance from Frankel and Rose (1998), Fidrmuc (2001) or Imbs (2004). The literature has proposed other candidate correlates of $\rho_{i,j}$. For instance, Imbs (2001) argues the sectoral specialization of trade matters in the presence of sectoral shocks. Baxter and Kouparitsas (2005) consider gravity variables or the composition of trade. Rose (2000) argues exchange rate arrangements and particularly currency unions act to synchronize international business cycles. Here I focus on trade and financial linkages. The foremost reason is this paper is concerned with the time pattern in $\rho_{i,j}$ over the past decade. Such focus immediately rules out correlates that are time invariant or persistent over time. This rules out gravity variables, but also the structure of production or of trade, which only change slowly over time. By the same token, currency unions or exchange rate regimes have not observably changed in the recent years. Inasmuch as we can observe them, goods and financial trade have altered drastically with the crisis. They are also at center stage of policy discussions about the international diffusion of a shock originally located in the U.S.

Turning to within country pair results, business cycles correlations increased in the last months of 2008. This was accompanied by a reallocation of both goods and assets trade. Cycle synchronization increased most between pairs of countries where both goods and financial trade rose. This holds constant the scale consequences the recession had on GDP level. Across the 39 countries with data since 2000, both trade and finance played a significant role in channeling a US shock across the world. The channels do however differ significantly in magnitude across sub-samples. Amongst OECD country pairs, it is the change in financial openness that correlates with the change in $\rho_{i,j}$, and the trade channel is virtually non existent. Amongst non OECD countries, both the significance and the point estimates suggest it is goods trade that dominates.

These correlations should not be interpreted causally, for both kinds of trade are eminently endogenous to the cycle, and cannot be instrumented in this panel framework. But the estimations do hold constant the changes in GDP induced by the recession, and thus changes in the scales of the trading economies, which are known to affect both goods

and assets trade. The estimations focus on the international allocation of goods and assets trade. The endogenous response of trade to the recession implies cycles should be synchronized between countries where trade has retreated, a negative bias. The results here point to the opposite correlation: synchronized countries trade relatively more with each other. The fact both goods and assets trade correlate with changes in $\rho_{i,j}$ suggests the conventional channel based on goods trade, central for example in the model developed by Kose and Yi (2006) or Burstein, Kurz and Tesar (2008), is not the only one at play in the data.

I begin to alleviate such endogeneity concerns, explaining the change in cycle correlations around the crisis date with trade intensity in the pre-crisis period. It is difficult to ascribe pre-crisis levels of goods or financial trade to the expectation of a subsequent synchronization of cycles with the advent of a largely unexpected crisis. The results of such a specification are in fact similar. The data suggest non OECD country pairs where goods trade was high *prior* to the crisis saw their correlation increase. In contrast, the diffusion channel for OECD countries appears to be strongest for country pairs with high financial linkages.

Financial openness correlates positively with $\rho_{i,j}$, which we knew in cross-section but not over time. The workhorse model of international business cycles with complete markets, due to Backus, Kehoe and Kydland (1994) implies that financially integrated economies correlate negatively. Technology shocks drive an international gap in marginal products of capital, which international investment chases. Investment rates correlate negatively across countries, and so do GDP fluctuations. Recently, Kalemli-Ozcan, Papaioannou, and Peydro (2009) have found evidence supportive of such a negative correlation in their setting. In their panel, financially integrated countries tend to be less synchronized. The finding is supportive of a complete market framework, even though it falls victim to the possibility that, prior to 2008, time-changes in $\rho_{i,j}$ tend to be too small to enable identification. Interestingly, the first clearly significant shift in the distribution of $\rho_{i,j}$ in several decades points to the opposite result. This confirms perhaps unsurprisingly a complete market framework with technologically induced fluctuations is unadapted to current developments. More interestingly, since I measure the allocation of asset trade across destination countries, the finding may be best understood as an endogenous portfolio reallocation decision. The decision would be driven by a US shock, but would have consequences on business cycles across investment destinations, and thus presumably on their synchronization. This requires a framework where portfolio decisions are made endogenously, and their effects on real activity taken into account. The recent methodologies developed by Devereux and Sutherland (2009) and Tille and Van Wincoop (2008) lend themselves to such general equilibrium analyses.

Ultimately, the challenge raised by these findings is to explain the joint importance of goods and assets trade. The results suggest a fundamentally different margin of ad-

justment in response to the sub-prime shock across OECD and non-OECD countries. The discrepancy can reflect a more advanced stage of financial integration amongst rich economies. In developing countries, it is goods trade that is relatively unhampered, and it is therefore the dominant response to the shock. In the rich world, the global recession is associated with falling asset trade. Perhaps because the role for multinational banks is more advanced there to start with, and de-leveraging is more prevalent.

It is important to reiterate these results cannot be explained away by the endogenous response of goods or assets trade to the recession, which implies the opposite correlation from the one documented here. Rather, the evidence calls for a theory where goods and assets trade are determined jointly in the presence of potentially heterogeneous costs. The framework introduced in Coeurdacier (2009) for instance can help answering the question whether cross-country differences in the relative magnitudes of goods and assets trade costs can begin to explain the differential responses we observe over the past year in response to a US based shock.

The rest of the paper is structured as follows. Section 2 introduces the variables of interest, i.e. the cross-section of cycles correlation, bilateral trade and openness to capital flows. The Section also describes the data used in computing all variables. Section 3 discusses the time pattern in bilateral cycle correlations. Section 4 investigates its trade and financial determinants in a panel framework. Section 5 concludes.

2 Measurement and Data

I first discuss the procedure used to track the distribution of cycle correlations over time, and the choices imposed by the necessity to have data on recent developments. I then describe the measures of bilateral trade intensity and financial openness.

2.1 The Time Pattern of Bilateral Correlations

The approach is directly inspired from the seminal contribution in Frankel and Rose (1998), and the extensive literature that followed to investigate the determinants of the international synchronization of business cycles. I estimate the lower triangular matrix of the Pearson correlation coefficients between all pairs of countries in a given sample. Each estimation is performed on a window of arbitrary length. I save the cross-sectional matrix of estimates, then roll the window forward in time, and repeat the procedure. The outcome is a panel formed by repeated cross-sections of cycle synchronization. This panel is the result of several choices of a relatively arbitrary nature, which I now discuss.

The length of each window determines the significance of the coefficients that form each cross-section. For an estimation of conventional Pearson correlation coefficients ρ

computed on N observations, we know

$$t = \frac{\rho}{\sqrt{(1-\rho^2)(N-2)}}$$

approximately follows a t-distribution with $N-2$ degrees of freedom. This provides a convenient rule of thumb to evaluate the significance of bilateral correlation coefficients. In most of the monthly data used here, correlation coefficients are computed on 60 months. For results based on monthly industrial production, correlations above 0.22 are therefore significant at the 10% confidence level. Some results are also presented using quarterly data, for which a minimum of 30 quarters are used, and coefficients above 0.31 can be considered significant at 10% confidence level.

There are alternative approaches in assessing the degree of international cycle synchronization. For instance, Alesina and Barro (2002) use the residual in a regression of GDP growth rates across countries. Giannone and Reichlin (2006) compute a coherence measure in the frequency domain, which arguably captures a broader spectrum of international cycles correlations. This paper makes use only of the Pearson correlation coefficient. This is for simplicity, intelligibility and comparability .The metric captured by $\rho_{i,j}$ has an immediate intuitive interpretation, and has indeed been used in the vast majority of this empirical literature, starting with Backus, Kehoe and Kydland (1992) and Frankel and Rose (1998).

The availability of recent data is of the essence in this paper. The onset of the crisis is typically dated to September 2008, with the bankruptcy of Lehman Brothers, or slightly less than two years ago at time of writing. It is crucial to have a sufficient number of observations posterior to the beginning of the crisis. The constraint conditions the type of data frequency that can be used here. With quarterly data, at best 4 or 5 observations are available since 2008Q3. With monthly data, up to 15 may be available. The paper makes use of monthly industrial production series, which are available from the IMF's International Financial Statistics. Industrial production is an imperfect measure of overall economic activity. It only captures a share of the overall economic activity, one that is shrinking as countries develop. And it largely abstracts from non-traded goods. So fluctuations in industrial production can appear to be correlated between trading partners because of such composition effects. Arguably, however, the implied mis-measurement is moving slowly over time. It is unlikely to have altered substantially since the onset of the 2008 crisis. The purpose of this paper is mostly to contrast estimates of the current pattern of international cycles synchronization to earlier estimates. It is in other words focused on the changes in correlations that can be imputed to the crisis. It is difficult to think of such high frequency change as driven by the fact industrial production measures imperfectly overall aggregate economic activitiy. Similarly, it is possible a measure focused on traded goods will act to magnify the empirical relevance of goods trade in this paper's

estimations. But this influence is presumably prevalent equally across time periods, and should therefore not affect dynamic, panel estimates.

Industrial production data exist for up to 39 countries, with uninterrupted coverage from 1980M1 until 2009M5. For simplicity and convenience, I focus on up to six sub-periods, namely 1980M1-1983M12, 1984M1-1988M12, 1989M1-1993M12, 1994M1-1998M12, 1999M1-2003M12 and 2004M1-2009M5. The first period runs 48 months, while the last is 65 months long. All others last precisely 5 years. Country coverage varies across periods. The first two periods have 24 countries, the third has 29, the fourth, 34, the fifth has 38 and the final period has 39 countries.[1] For each available cross-section of countries, the paper presents results for whichever of the six considered periods that have data. For instance, the distribution estimates are presented for the 24 countries with data over all six sub-samples. But estimates based on 38 countries are only presented for the last two sub-periods. The number of small countries - Cyprus, Romania, the Slovak Republic, Nicaragua or Armenia - increases as the estimation window covers more recent years. This will act to bias the results against finding evidence of a homogeneous shift in bilateral correations in recent years. In fact, the paper's main results strengthen with such economies omitted.

In order to date with precision the shift in the cross-sectional distribution of business cycles correlations, I also focus on the 2000's. I first consider five-year overlapping windows between 2000 and 2009, starting with 2000M1-2004M12 and separated by increments of 12 months. Only the latest of the five thus generated samples, ranging from 2004 to 2009, contains the start of the sub-prime crisis. I then refine the analysis further, and consider one-month increments of five-year windows, between 2003M6-2008M6 and 2004M5-2009M5. The fourth thus generated sub-sample starts including September 2008. This helps dating the month when the crisis starts affecting observably the international correlation in business cycles.

There are quite a few events that occurred since 1980 that are customarily construed as having had worldwide consequences. Identifying such events is the object of a large literature. Kose, Loungani and Terrones (2009) examine the global recessions implied by a world aggregate of per capita GDP. They conclude 1975, 1982 and 1991 are the only previous instances of world recessions in recent history. Yilmaz (2009) constructs an index of international spillover of national business cycles to identify periods of heightened interdependence, and find that 1975, 1981 and 2001 were periods of exceptionally high

[1]The 24 initial countries are: Austria, Barbados, Belgium, Denmark, Finland, France, Germany, Hungary, India, Ireland, Italy, Japan, Jordan, Korea, Luxembourg, Malaysia , Mexico, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and United States. The five additional countries from 1989 are Cyprus, Poland, Romania, the Slovak Republic and Turkey. From 1994, Croatia, the Czech Republic, Nicaragua, the Republic of Serbia and Tunisia become available. From 1999, Armenia, Canada, Greece and Lithuania have data. Finally, Bulgaria is included in the final period.

synchronization since 2008. They also find the index has taken unprecedently high values since 2008. Balakrishnan, Danninger, Elehdag and Tytell (2009) construct an index of global financial stress, and identify seven episodes when the index took unusually high values. The seven episodes are the Savings and Loans crisis, the October 1987 crash, the Nikkei crash, the European Exchange Rate Mechanism crisis, LTCM collapse, the Nasdaq crash, and U.S. bankruptcies in 2002. In this paper, I compare directly the cross-sectional distribution of $\rho_{i,j}$ in the current period with all of the earlier alternative periods of global recession the literature has identified.

For robustness purposes, the same exercises are performed on a sample of up to 44 countries with quarterly data on industrial production. Quarterly data from IFS are available from 1980Q1, and make it possible to estimate the distribution of cross-correlations over four non-overlapping periods of 30 quarters, namely 1980Q1-1987Q2, 1987Q3-1994Q4, 1995Q1-2002Q2, and 2002Q3-2009Q2. Thirty one countries are available from 1980Q1, 35 from 1987Q3, and 44 from 1995Q1.[2]

Industrial production is measured both in local currency and in US dollars, and reported with or without seasonal adjustment. The results presented in the body of the paper correspond to unadjusted local currency numbers, simply because that choice maximizes coverage. The same conclusions do obtain with USD or seasonally adjusted data. By the same token, the correlation coefficients are computed between the (logarithm) year-on-year differences of production, simply because growth rates are the most widely used numbers in reference to the onset of or the exit from a recession. An alternative is to detrend the series using a conventional filter to isolate its business cycle component. The body of the paper consist of results based on yearly growth rates, but similar conclusions obtain when the filter introduced by Baxter and King (1999) is implemented on the data instead.

2.2 Holding Volatility Constant

Correlation coefficients are not always suited to measuring structural changes in the diffusion mechanism of shocks. Whenever the underlying volatility alters - for instance an increase with the onset of a crisis - a measured rise in the measured correlation coefficient can merely reflect heightened volatility. To see the argument, developed among others in Forbes and Rigobon (2002) or Corsetti, Pericoli and Sbracia (2002), consider the following

[2]The 31 initial countries are Australia, Austria, Barbados, Belgium, Cyprus, Denmark, Fiji, Finland, France, Germany, Hungary, India, Ireland, Italy, Japan, Jordan, Korea, Luxembourg, Malaysia, Mexico, Netherlands, Nigeria, Norway, Portugal, Spain, Sweden, Switzerland , Trinidad and Tobago, Turkey, United Kingdom, and United States. From 1987Q3, New Zealand, Poland, Romania and the Slovak Republic become available. From 1995Q1, Armenia, Canada, China, Croatia, the Czech Republic, Greece, Lithuania, Nicaragua and Tunisia become available.

structural linear relation between GDP growth in countries i and j:

$$g_i = \alpha + \beta g_j + \nu_i$$

where g_x denotes the growth rate of GDP in country x and ν_i is the residual growth in g_i. If the very nature of shock diffusion alters, one should observe a shift in the estimate of β.

The correlation coefficient between GDP growth rates ρ_{ij} does not map one for one with estimates of β. To see this, rewrite

$$\rho_{ij} = \left(1 + \frac{var\nu_i}{\beta^2 var g_j}\right)^{-\frac{1}{2}} \tag{1}$$

Holding β constant, ρ_{ij} responds to any change in the relative variance of GDP growth rates across countries. In particular, estimates of ρ_{ij} rise systematically if a crisis in country j increases the volatility of GDP there, $varg_j$ - even though β has remained constant.

Following Forbes and Rigobon (2002), consider now additive changes in the volatilities in both countries i and j. Define

$$varg|Crisis = (1 + \delta_j)\, varg_j$$

and

$$var\nu_i|Crisis = (1 + \delta_i)\, var\nu_i$$

δ_i and δ_j capture the country specific shifts in the volatility of GDP growth that can potentially occur with the crisis. Define the post-crisis correlation coefficient $\rho_{ij}|Crisis$. It is easy to show that

$$\rho_{ij}|Corrected = \left[\frac{1 + \delta_j}{1 + \delta_i}\left(\rho_{ij}|Crisis\right)^{-2} + \frac{\delta_i - \delta_j}{1 + \delta_i}\right]^{-\frac{1}{2}} \tag{2}$$

The expression provides a correction of $\rho_{ij}|Crisis$ that can be implemented to hold constant the consequences on the correlation coefficient of a shift in volatilities around a crisis period. If $\rho_{ij}|Corrected$ continues to increase around the crisis date, it must be because β has augmented, i.e. the very mechanism of shock diffusion has changed. Note that, consistent with equation (1), a symmetric change in the variances of GDP across countries has no consequences on $\rho_{ij}|Corrected$. In what follows, I estimate the variance o GDP growth rates around the crisis date. I obtain values for δ_i and δ_j for all country pairs, and correct the raw estimates of $\rho_{ij}|Crisis$ using equation (2). I also keep track of uncorrected estimates of $\rho_{ij}|Crisis$, in order to gauge the importance (and asymmetry) of the change in GDP volatility triggered by the crisis.

2.3 Trade and Financial Linkages

The paper relates the cross-section of cycle correlations with two of its conventional determinants. Frankel and Rose (1998) forcefully established the relevance of trade intensity as a driver of the international business cycle. Cycles between trade partners are significantly more correlated, so much so that the estimated elasticity is in fact hard to reproduce in a general equilibrium model of the business cycle. This was labeled a "trade-comovement" puzzle by Kose and Yi (2006).

The conventional approach implements data from the IMF's Direction of Trade data to compute

$$T_{i,j} = \frac{X_{i,j} + X_{j,i}}{X_i + X_j}$$

where $X_{i,j}$ denotes total merchandise exports from country i to j and $X_i = \sum_j X_{i,j}$. Trade intensity is typically measured at the beginning of the period to assuage endogeneity concerns, and the same will be true here. Even so, external instruments are typically indispensable because trade patterns are persistent over time. Instruments for trade are based on gravity arguments, and include variables such as geographic proximity, the presence of a common border, a common colonial history, languages or access to an open body of water. Most of these instruments are constant over time, and thus cannot be used in this paper, where the time dimension is of the essence. This conditions the interpretation of the results, which should not be taken in a causal sense, but rather in a purely descriptive one. I seek to evaluate whether the time pattern of $\rho_{i,j}$ correlates with changes in trade intensity, bearing in mind the sub-prime shock may have conjointly increased cycle correlations, and lowered goods or assets trade.

The measure $T_{i,j}$ focuses on the allocation of trade. But the intensity of goods trade will also mechanically respond to the scale of the economy. Total demand falls in a recession, so in particular does the demand for foreign goods. It is important therefore to hold constant the sizes of the trading economies. I do so including the pairwise sum of nominal GDP, $Y_i + Y_j$. Thus T evaluates the importance of goods trade between i and j *relative* to the rest of the world in explaining $\rho_{i,j}$, holding constant the sizes of tre trading economies.

Financial linkages are an especially pertinent channel in the current context. Unfortunately, available bilateral data on financial flows do not yet cover the current crisis. The Country Portfolio Investment Survey (CPIS) supervised by the IMF, and released on a yearly basis stops in 2007 at time of writing. And the Bank of International Settlements (BIS) "locational bank statistics" are only available bilaterally for a reduced cross-section of lending economies, limited to OECD countries. In this paper, I propose to approximate bilateral financial openness with country specific data. I consider conventional measures of bank lending, taking inspiration from Lane and Milesi-Ferretti (2001, 2007, 2008). I

construct the share of external lending by banks relative to the size of the lending economy. The data are available from the BIS's "locational banking statistics", at least until 2008Q4.

The locational banking statistics gather quarterly data on international financial claims and liabilities of bank offices in the reporting countries. Both domestically owned and foreign-owned banking offices in the reporting countries record their positions on a gross (unconsolidated) basis, including those vis-à-vis own affiliates in other countries. This is consistent with the residency principle of national accounts, balance of payments and external debt statistics. The variable brings the focus on the role of banks' international linkages for the diffusion of the current crisis. A "retrenchment" argument is often heard to account for the global nature of the current crisis, and financial intermediaries are often accused of "deleveraging" their balance sheets, thus contributing to the international diffusion of an originally US-based shock. BIS data are therefore directly relevant to the question at hand. I have also verified that data on capital account from the IMF's International Financial Statistics imply similar conclusions.[3]

The BIS data used here are not bilateral. This is a serious shortcoming, especially relative to information on goods trade. I propose an approximating shortcut, and compute a bilateralized version of the BIS data, given by

$$\phi_{i,j} = \frac{(A_i + L_i) + (A_j + L_j)}{\sum_i (A_i + L_i) + \sum_j (A_j + L_j)}$$

where A_i and L_i are measures of banks claims and liabilities in country i. The contention implicit in the interpretation of $\phi_{i,j}$ as a measure of bilateral financial linkage is that countries that are both open to capital flows will tend to be open to each other.

As was the case for goods trade, scale can matter for assets trade. Portfolio shares, for instance, reflect the relative size of financial markets and their underlying economies in a complete markets model of international portfolio choice. Thus, financial trade will fall endogenously as economies enter in recession. Holding $Y_i + Y_j$ constant continues therefore to be important. The focus is squarely on the international allocation of assets, holding constant the underlying size of the economy.

[3]One of the attractions of IMF data is they make it possible to decompose international positions into portfolio, direct investment, or financial derivatives. The importance of the latter in journalistic accounts of the current developments make IFS data an interesting alternative to those released by the BIS. On the other hand, IFS report flow data, as opposed to the stocks of assets and liabilities reported for banks in the locational banking statistics used here. Financial linkages are surely best captured by stock data.

3 The First Global Recession in Decades

This Section discusses the patterns observed in the cross-section of bilateral cycle correlations. It presents the results that pertain to the whole sample of countries, then draws comparisons between the recent period and previous worldwide shocks. The Section closes with sample splits and some robustness.

3.1 World Business Cycles

Throughout the paper, the reported distributions are based on Epanechnikov kernel estimates. Ninety percent confidence intervals are also reported, which reflect the asymptotic standard error bands implied by the kernel. Figure 1 reports the estimates for the six sub-periods considered in monthly data. There are 24 countries with monthly industrial production, so that each distribution is estimated on the basis of 276 bilateral correlations. Since they are estimated over 60 months, any correlation above 0.22 can be considered significantly different from zero at a 90% confidence level. Each panel reports in thin lines the distribution estimates corresponding to the most recent period, where volatility is held constant at its 1999M1-2003M12 level according to equation (2). The last panel in Figure 1 reports both the corrected and uncorrected correlations for the most recent crisis period.

Until the late 1990's, the cross-sectional distributions are centered around barely significant values. In the first four sub-periods, the distributions modes are positive, but below 0.4. Most bilateral correlations until the late 1990's are therefore close to zero, with low degrees of skewness. Most correlations are also significantly lower than their corrected counterpart estimated between 2004M5 and 2009M4. It is only between 1999M1 and 2003M12 that the distribution begins to appear to shift to the right and become skewed to the left. The mode shifts slightly upwards, above 0.5. This may reflect what happened in the wake of the Asian crisis, with more bilateral correlations taking significantly positive values. Most correlations continue however to be significantly smaller than estimates from the most recent period.

The striking result in Figure 1 pertains to the last, most recent, period. With data between 2004M5 and 2009M4, the distribution becomes heavily skewed to the left, with a mode above 0.8. Most correlations have become significantly positive at any conventional confidence level, and only few country pairs display negative correlations. Comparing the most recent 5 years with any earlier period with available data, it is patent a significant upwards shift in cycle synchronization has happened. It is tempting to associate it with the sub-prime crisis.

Importantly, the shift happened over and above volatility changes. The last panel in Figure 1 compares the kernel estimates of $\rho_{ij}|Crisis$ and $\rho_{ij}|Corrected$. Corrected

correlations are smaller, but typically not significantly so. This does not mean volatilities did not change with the 2008 crisis. Indeed quite the contrary. Rather, it means *all* volatilities increased with the crisis, so that $\delta_i \simeq \delta_j$ for most i, j. The correction in equation (2) appears to be less pertinent for the 2008 crisis, precisely because its global dimension has affected *both* β *and* volatilities everywhere.

This remarkable pattern is not an artefact of a sample focused on 24 countries only. Figure 2 considers the 39 countries with data since 2000. The results are similar. Prior to the last period, distribution estimates are centered around zero. But the figure points to a large and significant shift in the distribution over the recent period. The distribution mode is above 0.7 for corrected correlations computed between 2004 and 2009, but it is barely significant for all earlier periods. Interestingly, the Figure suggests the shift upwards in the late 1990's apparent from Figure 1 may have been an artefact of sampling.

In order to identify the timing of this shift with more precision, Figure 3 presents estimates corresponding to the twelve overlapping 5-year windows between 2003M6-2008M6 and 2004M5-2009M4, separated by one month increments. As in earlier Figures, the correlations computed over the most recent period 2004M5 - 2009M4 are corrected to the variance levels of the earliest preiod in the Figure, 2003M6 - 2008M6. The purpose of Figure 3 is to identify the time period when the distribution of correlations starts converging to $\rho_{ij}|Corrected$, reported in thin range lines in the Figure. Therefore, unlike Figures 1 and 2, *all* kernel estimates are corrected to 2003M6 - 2008M6 volatility levels.

The estimated distribution shifts upwards slightly in 2003M12-2008M12, and becomes bimodal. That stands in contrast with the previous periods, when distributions were centered around 0. From 2004M1-2009M1, the estimated distributions become skewed to the left, with fewer still negative correlations. The mode increases to 0.7. The skewness intensifies markedly thereafter, and the modes for the last four estimated distributions in Figure 3 are all above 0.8. At face value, Figure 3 is strongly suggestive that a shock occurred in the very last months of 2008, which started having strong synchronizing effects on the world business cycle from the first months of 2009. It is difficult not to think of the sub-prime crisis as the culprit for these developments.

3.2 Comparisons

Is the global increase in cycles correlations as unprecedented as the figures in this paper suggest? For instance from Figure 1, the cross-sectional distribution of cycle correlation has not been centered at such high level as they are now since the 1980's, at least amongst the 29 countries considered there. An important experiment is to compare the current period and what happened around the time of an arguably similarly global shock. A large literature has sought to identify such events with global consequences. A first

approach, followed by Kose et al (2009), consists in identifying slumps in world GDP. An alternative, followed by Yilmaz (2009) uses VAR techniques to isolate periods of increased interdependence across countries. Balakrishnan et al (2009) construct an index of global financial stress, and identify periods when the index takes exceptionally high values. Combining the findings of this literature, I identify eight alternative episodes of global recession. They are the oil shock of 1973, the Savings and Loans crisis, the October 1987 crash, the Nikkei crash, the European Exchange Rate Mechanism crisis, LTCM collapse, the Nasdaq crash, and the U.S. bankruptcies of 2002.

Figure 4 plots the estimated distributions of $\rho_{i,j}$ immediately after each one of these shocks, along with the distribution corresponding to the most recent period with available data. The latter distribution is corrected to 2003M1 - 2007M12 levels of GDP volatility. Correlations corresponding to earlier periods, in contrast, are *not* corrected. This will tend to stack the deck against finding evidence of systematically higher correlations since 2008. The earlier distribution estimates are probably biased upwards, as they are computed on the basis of crises volatilities, and thus driven upwards artificially. Furthermore, the eight alternative distributions are estimated over periods that *begin* with the conventional date of the world shock. In contrast, because of data limitations, the most recent period only includes a few months after the sub-prime shock.

Despite both of these choices, Figure 4 unambiguously shows the distribution of $\rho_{i,j}$ from the recent months is significantly further to the right than it has ever been in any of the considered episodes. In fact, the mode of the most recent distribution is above 0.8, whereas it is rarely above 0.5 in earlier instances. Skewness is also markedly higher. One exception may be the oil shock of 1973, when the distribution estimate is not significantly below that obtained from 2004M5 - 2009M4. Recall the 1973 kernel is based on GDP volatilities during the oil shock, which may have markedly increased. More to the point, there are only 16 countries with monthly industrial production data from 1973. The kernel is therefore estimated on 120 observations. This explains the wide confidence intervals surrounding the 1973 kernel on the first panel of Figure 4. In fact, inaccuracy in estimates is the main reason there are no significant differences between the two dsitributions on the panel. Most point estimates of the 1973 correlations are in fact below their 2008 counterparts. The current developments do appear to have triggered the first global recession in decades - at least since 1980, perhaps even since the 1970's.

It remains to be seen whether the evolution just documented has affected indifferently rich and developing economies. A common view is the sub-prime shock has originated in the US, and its international impact turned out to be virtually universal. Few if any countries escaped the fallout. Figure 5 investigates the question, on the basis of a sample split according to income level. The estimates reproduce what was presented in Figure 2, but separating out OECD and non-OECD country pairs.[4] Year-by-year

[4]Mixed country pairs have virtually identical properties to non-OECD pairs.

distribution estimates are presented for two sub-groups of countries. The first includes 19 rich economies in the sample of 39 countries that underpin Figure 2.[5] The second includes the remaining 20 developing economies.[6]

Figure 5 provides a clear-cut illustration that the recent synchronization in business cycles is clearly at play within the rich world. For most earlier periods, rich countries appear to be slightly more correlated, with larger distribution modes, although the difference is not always significant. Perhaps this happens because they trade more, or they are less volatile. But when the recent period is included, the corrected kernel estimates start implying a heavily skewed distribution, with a mode above 0.8. In fact, the extreme skewness estimated over 2004M5-2009M4 in the rich world is even higher than its counterpart in Figure 2. From the early months of 2009, the international correlation of business cycles between rich countries increases significantly. This is an unprecedented global recession for the rich world.

The shift in the distributions is much less apparent amongst developing countries. Cycles are less correlated to start with amongst developing economies than in the OECD - with modes between 0 and 0.5. It is also less evident that correlations increase significantly when the current period is included. The last period in Figure 5 is indeed slightly skewed to the left, with a mode above 0.5. But the shift is smaller than what happened in the OECD. The developing world, as reflected by the 20 economies included in the sample on Figure 5, has so far remained relatively insulated from the sub-prime crisis.

All the results detailed up to now rest on monthly industrial production that was not seasonally adjusted, in order to maximize country coverage. Even though growth rates were computed on a year-to-year basis, it is important to ascertain the large shifts we observe in the recent period are unrelated to seasonal developments. Table 1 presents selected percentiles of the estimated distributions using alternative data sources. The first panel reproduces the findings in Figure 2. There is a significant shift upwards of lower quartile, median and mean estimates in the period 2004-2009. The second panel of the Table reports the same moments estimated on the basis of seasonally adjusted data. With seasonal adjustment, all estimated correlations tend to increase, across all periods, relative to unadjusted data. All moments tend to take larger values. But it continues to be the case the last period is characterized by a large increase in the skewness of the distribution. The mean jumps to more than twice the median value, a feature that is absent from all earlier periods. In fact, skewness becomes even larger with seasonally adjusted data than

[5]They are: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and United States.

[6]They are: Armenia, Barbados, Bulgaria, Croatia, Cyprus, the Czech Republic, Hungary, India, Jordan, Korea, Lithuania, Malaysia, Mexico, Nicaragua, Poland, Romania, the Republic of Serbia, the Slovak Republic, Tunisia and Turkey.

it does in Figure 2 and in the main body of the text. In short, seasonality explains none of the results in this paper.

Finally, industrial production is also available at the quarterly frequency. With 44 countries, the country coverage is broader than for monthly production, which is interesting for comparison purposes. On the other hand, quarterly data have by construction few observations that are posterior to the onset of the sub-prime crisis. The lower panel of Table 1 presents the key moments of the distribution of $\rho_{i,j}$ over three sub-periods corresponding to quarterly data. Only the third, most recent one includes crisis quarters. It is significantly shifted to the right relative to earlier samples. In other words, country coverage or frequency of observations are probably not driving the results in this paper.

4 Trade and Financial Openness

This section presents conventional regressions of the determinants of business cycles synchronization, following the tradition pioneered by Frankel and Rose (1998). The focus is on the time changes in the cross-section of bilateral correlations. The section also discusses the correlates of the difference in distribution dynamics between rich and developing countries. I examine the determinants of cycles synchronization over the early 2000's (from 2000M1-2004M12), and contrast them with the most recent period, inclusive of the current recession (from 2004M5 to 2009M4). Then I ask how both trade and financial linkages contribute to explaining changes in cycles synchronization in both regions.

The specification of the estimated regressions takes inspiration from Frankel and Rose (1998), Imbs (2004, 2006), or Kalemli-Ozcan, Papaioannou, and Peydro (2009). I regress a given cross-section of bilateral correlations, denoted $\rho_{i,j}$, on the corresponding measure of financial openness $\phi_{i,j}$, and on trade intensity $T_{i,j}$. The specification writes

$$\rho_{i,j} = \alpha_0 + \alpha_1 T_{i,j} + \alpha_2 \phi_{i,j} + \alpha_3 \left(Y_i + Y_j\right) + \varepsilon_{i,j} \tag{3}$$

where $Y_i + Y_j$ is the pairwise sum of nominal GDP, and holds the scale of the economy constant. The residual $\varepsilon_{i,j}$ is liable to have a heteroskedastic structure reflective of measurement error specific to a given country i. This may contaminate all pairs country i is part of. I account for this possibility via clustering of the residual along the country dimension. The coefficients α_1 and α_2 reflect the possibility that the international allocation of trade and financial linkages affects cycles correlations. The controls for $Y_i + Y_j$ helps differentiate the crisis-induced changes in the scale of trade relative to the (shrinking) economy, from shifts in the relative magnitude of trade across partner countries.

Be that as it may, all coefficient estimates are to be understood as a check against standard results, rather than for causal interpretation. In particular, Frankel and Rose

(1998) famously established α_1 is positive and significant, for a wide range of country coverages and time periods. Imbs (2004, 2006) showed bilateral measures of financial integration taken from the IMF's Country Portfolio Investment Survey also correlate positively with $\rho_{i,j}$, even when instrumented with institutional variables capturing the depth of financial markets.

Table 2 reports summary statistics for the three variables of interest, over the 39 countries with monthly industrial production since 2000. The average bilateral correlation increased from 0.25 in the early 2000's to 0.55 over the last 5 years. The increase is prevalent in both rich and developing economies, though more pronounced in the former. The average values for T and ϕ barely altered between 2000 and 2009. For instance, the average bilateral trade relation accounts for around 1% of overall trade in the representative country. That proportion barely changed over the 2000's. The proportion appears to be slightly higher for OECD countries than in the developing world, where it does however remain largely unchanged through the 2000's. For instance, T was 0.284 between the US and Mexico in 2000, and rose to 0.298 by 2008Q4. Between the UK and the US, it fell slightly from 0.092 to 0.081, while it went from 0.021 to 0.036 between India and Japan. Over the same period, ϕ went from 0.253 to 0.235 between the US and Mexico, from 0.447 to 0.462 between the UK and the US, and from 0.086 to 0.035 between India and Japan.

Table 3 presents the estimation results for equation (3), over the first and second halves of the 2000's. The first two specifications present the coefficients estimates corresponding to the whole sample of 39 countries. In line with Frankel and Rose (1998), α_1 is positive and significant. In line with the results in Imbs (2004, 2006), so is α_2, although not systematically. This suggests the *relative* degree of international exposure of banks correlates positively with $\rho_{i,j}$. Country pairs where banks tend to be especially invested abroad tend to be highly correlated. The next columns in Table 3 include interactions with a binary variable corresponding to GDP levels in countries i and j, namely

$$\rho_{i,j} = \beta_0 + \beta_1 T_{i,j} + \beta_2 T_{i,j} \cdot D_{i,j} + \beta_3 \phi_{i,j} + \beta_4 \phi_{i,j} \cdot D_{i,j} + \beta_5 \left(Y_i + Y_j\right) + \varepsilon_{i,j} \qquad (4)$$

$D_{i,j}$ denotes alternatively OECD or non OECD country pairs. Estimates of β_1 continue to be significantly positive, but β_2 tends to be negative for country-pairs in the OECD. This suggests the goods trade channel is quantitatively less important amongst rich countries. Estimates of β_3 are positive, but not always significant.

Table 4 presents fixed effects estimates of equations (3) and (4). On the basis of the whole sample, both T and ϕ correlate positively with the time change in ρ. The increase in cycles correlations was associated with a re-location of goods and financial trade across partner countries: Cycle synchronization rose as both types of trade increased.

Splitting the sample into rich and developing economies is informative. Amongst OECD pairs, β_1 is almost equal to $-\beta_2$, and both are significant. Goods trade is not

a relevant channel of diffusion of the crisis between rich countries. β_3 is significant and positive, but β_4 is zero. In other words, financially open rich countries are synchronized, holding constant their economic size and time-invariant country-pair effects.

The opposite tends to be true for non OECD country pairs, where β_1 is positive and significant, but β_2 equals zero once the correlations are corrected for chages in variances. Goods trade is the most important channel there. Financial openness, in turn, is weakly significant and still positive, especially with corrected variances. In other words, cycles correlation increased slightly in the developing world, and that seems to have been associated with an increase in bilateral relative to overall trade. A reallocation mechanism is also at play, but via goods rather than financial markets. In terms of explanatory power, the within-R^2 falls from 0.54 to 0.21 when the financial variables are omitted for rich countries, and from 0.40 to 0.23 when trade variables are omitted for developing economies.

Some caution is in order when it comes to interpreting these results. There is nothing causal in these correlations, as goods and assets trade respond endogenously to the crisis. We saw $\rho_{i,j}$ increased in the more recent period, and goods or financial trade conjointly reallocated as exporters withdrew and financial intermediaries "deleveraged". Both phenomena likely happened in response to the same (omitted) shock. The difference in estimates across samples, however, is informative, for it suggests the response to the shock differed fundamentally in the rich and developing worlds. That said, the endogeneity of T and ϕ presumably tends to bias estimates of α towards negative values, as goods trade and bank linkages reallocate away from countries hit hardest by the slump. The estimates for α are positive here, so that an endogeneity bias acts against the results in this paper.

This is confirmed in Table 5, where the change in $\rho_{i,j}$ is regressed on the *initial*, pre-crisis levels of $T_{i,j}$ and $\phi_{i,j}$. The specification begins to alleviate endogeneity issues. It is indeed difficult to think of the pre-crisis patterns of trade as endogenously determined by the subsequent time-pattern of $\rho_{i,j}$, especially since the change occurred with a largely unexpected crisis. The Table shows that pre-crisis intensity in goods trade is largely orthogonal to subsequent changes in $\rho_{i,j}$ amongst OECD countries. It is between the OECD countries where $\phi_{i,j}$ takes highest values prior to the crisis that correlations increased most. Amongst non OECD pairs, in contrast, it is a channel based on goods trade that is most significant - and positive when conditioned on a non OECD sample. Financial linkages do appear to matter there as well, but not in a manner that is specific to that sub-sample.

5 Implications and Concluding Comments

This paper presents some descriptive evidence of the changes in the patterns of international business cycles correlations over the past three decades, with a focus on the 2008-2009 turmoil. I document a large and significant positive shift in the cross-sectional distribution of bilateral correlations since the early months of 2009. Including the most recent 6 months of data implies distribution estimates that are heavily skewed to the left, with modes above 0.8, significantly positive at any standard confidence levels. This shift is robust across various measures of the business cycle. Previous prominent instances of a global shock did not come close to triggering a similarly significant response of distribution estimates. In fact, no other sub-period since the 1980's can be characterized by a similarly skewed distribution. This remains true when the volatility of GDP is held constant at its pre-crisis level. In that sense, the current turmoil is effectively the first global recession in decades.

Its effects are however mostly felt in the developed world. Bilateral correlations changed less in a sub-sample formed exclusively by developing economies, which appear to have so far "decoupled" from the global cycle.[7] In the developing world, it is the allocation of goods trade that correlates significantly with changes in $\rho_{i,j}$. Goods trade increased in relative terms between synchronizing pairs of developing countries, although the synchronization itself was somewhat muted. In the OECD, goods trade is much less significant, if at all. Rather, it is where financial links - as measured by banks holdings - are highest that $\rho_{i,j}$ increased most. For OECD countries, the channel of diffusion appears to work directly via bank linkages

These findings have two interpretations, that are not necessarily mutually exclusive. First, the mechanisms that transmit shocks across countries have changed fundamentally since 2008. Financial integration of a specific kind, involving financial intermediaries, reached a threshold level that makes the system vulnerable to a given shock. There is a threshold beyond which the resilience of the international economy to a given shock collapses. This can happen as the level of interdependence between banks is such that a local shock becomes global almost on impact. It diffuses immediately through financial linkages, with rapid consequences on the real economy. It does so within a financially integrated world, i.e. amongst developed countries. Within the developing world, in contrast, financial linkages are weaker, and the diffusion happens via the goods trade channel. This appears to delay the transmission of the shock, and potentially dilute somewhat its consequences on the real economy.

It is also possible the very nature of the 2008 shock is unprecedented. This is not meant in terms of its magnitude, since estimates in this paper hold the volatility of GDP

[7] Kose, Otrok and Prasad (2008) reach a similar conclusion.

constant around the crisis dates. Major financial shocks that affect the balance sheet of a large proportion of financial intermediaries in the largest world economy are few and far between. The alternative shocks considered in this paper are supposed to have characterized previous instances of global recessions, but they may have been more segmented or specialized in their consequences on both the financial sector and utlimately the real economy. The 2008-2009 crisis was different in that the shock virtually affected the universe of financial intermediaries in the US. That must have favored an international transmission via financial linkages and especially bank holdings, wherever they were intense.

Under the latter scenario, all policy can do is prepare the conditions that will limit the diffusion of the shock, or its effect on the real economy. This opens up two promising research avenues. First, can we identify the putative threshold of resilience beyond which a given shock starts having immediate global consequences. Does a threshold exist no matter the kind of financial integration? Can policy change the very existence of such a threshold by modifying the institutional or regulatory environment? What are the importance of financial vs. goods trade linkages? Some of the papers in this volume make progress on this front. Cetorelli and Goldberg (2009) identify how it is a specific kind of response of lending supply on the part of global banks that channeled the financial shock across countries. Giannone, Lenza and Reichlin (2010) show the regulation in credit markets, and in particular measures of governance, have tended to limit the international diffusion of the initial US shock. Turning to goods trade, Levchenko, Lewis and Tesar (2009) and Bems, Johnson and Yi (2010) show the unprecedented collapse of world trade fell disproportionately on intermediary goods, suggesting production linkages were central to the diffusion of the shock into the developing world.

A second set of questions concerns the channel of diffusion from the financial to the real economy, and its heterogeneity across countries. Why have the real effects of the shock been heterogeneous across countries? And why do trade linkages seem to dampen these effects, whereas financial trade does not? The answers seem to be found in the background macroeconomic environment prior to the crisis. For emerging markets, Blanchard, Faruqee and Das (2010) confirm both financial and trade variables mattered, but their end consequences on the real economy depended on the specific policy actions around the crisis period. Lane and Milesi-Ferreti (2010) go further to show financial linkages themselves cease to be empirically relevant once controls are included for pre-crisis credit conditions or external vulnerabilities. The finding in this paper that trade or financial linkages do not matter equally across countries seems to suggest an additional consideration is relevant, namely the pre-crisis level of *both* goods and financial trade integration. Both margins are empirically relevant, and future research should consider both.

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Table 1: Robustness

Dates	Monthly NSA			Monthly SA		
	Bottom 25%	Median	Mean	Bottom 25%	Median	Mean
2000M1-2004M12	0.092 [0.059;0.135]	0.585 [0.547;0.737]	0.586 [0.526;0.681]	0.250 [0.193;0.378]	0.632 [0.527;0.782]	0.652 [0.553;0.791]
2001M1-2005M12	0.079 [0.054;0.137]	0.435 [0.360;0.531]	0.610 [0.543;0.709]	0.147 [0.085;0.223]	0.667 [0.559;0.839]	0.629 [0.527;0.765]
2002M1-2006M12	0.064 [0.028;0.099]	0.474 [0.391;0.578]	0.658 [0.586;0.765]	0.347 [0.253;0.485]	0.859 [0.743;1.088]	0.810 [0.682;0.988]
2003M1-2007M12	0.100 [0.056;0.141]	0.503 [0.422;0.609]	0.656 [0.585;0.762]	0.074 [0.025;0.150]	0.467 [0.347;0.617]	0.668 [0.553;0.814]
2004M5-2009M4	0.293 [0.239;0.376]	0.717 [0.660;0.866]	0.738 [0.674;0.858]	0.219 [0.084;0.263]	0.333 [0.237;0.495]	0.789 [0.651;0.964]

Dates	Quarterly NSA		
	Bottom 25%	Median	Mean
1999Q4-2007Q2	0.125 [0.093;0.180]	0.642 [0.586;0.777]	0.562 [0.499;0.652]
2000Q4-2008Q2	0.073 [0.035;0.101]	0.500 [0.432;0.609]	0.554 [0.489;0.644]
2001Q4-2009Q2	0.214 [0.164;0.277]	0.617 [0.553;0.737]	0.611 [0.547;0.709]

Notes: The table reports the lower quartile, median and mean of the cross-sectional distribution of $\rho_{i,j}$. The numbers between brackets represent 95% confidence intervals. "Monthly NSA" uses non-seasonally adjusted industrial production, as in the main text. "Monthly SA" uses seasonally adjusted industrial production, and "Quarterly NSA" uses non-seasonally adjusted quarterly industrial production..

Table 2: Summary Statistics

	Whole Sample		OECD		Non OECD	
	2000	2009	2000	2009	2000	2009
ρ	0.251 (0.278)	0.554 (0.268)	0.280 (0.273)	0.578 (0.271)	0.166 (0.274)	0.485 (0.250)
T	0.012 (0.031)	0.014 (0.031)	0.015 (0.035)	0.016 (0.034)	0.003 (0.011)	0.008 (0.017)
ϕ	0.051 (0.072)	0.051 (0.073)	0.068 (0.077)	0.067 (0.078)	0.003 (0.003)	0.004 (0.002)
Nobs	741	741	551	551	190	190

Notes: The table reports means and standard deviations. ρ is the Pearson coefficient, computed using monthly industrial production over 2000M1-2004M12 for the earlier period (2000), and over 2004M5-2009M4 for the latter (2009). T denotes bilateral trade intensity, ϕ denotes financial linkages. Both variables are defined in the text. OECD denotes all pairs of countries involving at least one rich economy. Non-OECD denotes all pairs of developing countries.

Table 3: Period by Period Determinants of Cycles Synchronization

	Whole Sample		OECD Pairs		Non OECD Pairs	
	2000	2009	2000	2009	2000	2009
T	1.972^{***} (0.437)	1.598^{***} (0.494)	2.787^{***} (0.866)	3.012^{***} (1.033)	2.046^{***} (0.432)	1.367^{***} (0.425)
$T \cdot D$			-1.330 (0.944)	-2.144^{**} (1.088)	-1.941 (2.010)	2.951^{***} (0.991)
ϕ	0.334^{*} (0.179)	0.035 (0.200)	0.132 (0.262)	0.072 (0.195)	0.394^{*} (0.229)	0.108 (0.177)
$\phi \cdot D$			0.494^{*} (0.264)	0.168 (0.213)	7.538 (5.010)	0.226 (4.951)
$Y_i + Y_j$	$1.34 \cdot 10^{-8**}$ $(6.00 \cdot 10^{-9})$	$1.44 \cdot 10^{-8***}$ $(3.45 \cdot 10^{-9})$	$1.23 \cdot 10^{-8*}$ $(7.40 \cdot 10^{-9})$	$1.31 \cdot 10^{-8***}$ $(3.91 \cdot 10^{-9})$	$1.24 \cdot 10^{-8*}$ $(7.48 \cdot 10^{-9})$	$1.47 \cdot 10^{-8***}$ $(4.00 \cdot 10^{-9})$
R^2	0.117	0.100	0.123	0.115	0.121	0.110
$Obs.$	701	701	701	701	701	701

Notes: The left-hand side is the cross-section of $\rho_{i,j}$ as defined in the text. The correlations $\rho_{i,j}$ are computed using monthly industrial production over 2000M1-2004M12 for the earlier period (2000), and over 2004M5-2009M4 for the latter (2009). The variables T and ϕ are defined in the text. $Y_i + Y_j$ is the pairwise sum of GDP. For OECD specifications, D denotes a binary variable taking value 1 for pairs of countries both in the OECD. In non-OECD specifications, D denotes a binary variable taking value 1 for pairs of countries both outside of the OECD. Trade T is measured in 2000Q1 for the early period, and in 2008Q4 for the later one. Financial linkages ϕ are measured in 2000Q1 for the early period, and in 2008Q4 for the later one. Standard errors are clustered by country. *** (**, *) denote significance at the 1% (5%, 10%) confidence level.

Table 4: Within Country Pair Estimations

	Whole Sample	Corr.	OECD	OECD Corr	Non OECD	Non OECD Corr
T	14.332^{***} (2.198)	11.429^{***} (1.793)	22.098^{***} (3.639)	18.206^{***} (3.002)	10.996^{***} (2.152)	9.307^{***} (1.855)
$T \cdot D$			-20.004^{***} (4.933)	-17.728^{***} (3.991)	10.036^{*} (5.882)	6.538 (4.673)
ϕ	1.443^{*} (0.764)	1.915^{***} (0.611)	2.501^{**} (1.186)	2.287^{**} (0.923)	1.374^{*} (0.740)	1.898^{***} (0.594)
$\phi \cdot D$			-2.134 (1.483)	-0.683 (1.149)	9.199 (16.942)	-1.826 (13.282)
$Y_i + Y_j$	$1.38 \cdot 10^{-7***}$ ($1.38 \cdot 10^{-8}$)	$1.08 \cdot 10^{-7***}$ ($1.17 \cdot 10^{-8}$)	$1.23 \cdot 10^{-7***}$ ($1.19 \cdot 10^{-8}$)	$9.41 \cdot 10^{-8***}$ ($1.17 \cdot 10^{-8}$)	$1.38 \cdot 10^{-7***}$ ($1.20 \cdot 10^{-8}$)	$1.07 \cdot 10^{-7***}$ ($1.16 \cdot 10^{-8}$)
Within R^2	0.243	0.213	0.269	0.240	0.250	0.216
Obs.	1402	1402	1402	1402	1402	1402

Notes: The left-hand side is the change in bilateral correlations $\rho_{i,j}$ over the two periods 2000M1-2004M12 and 2004M5-2009M4. The variables T and ϕ are defined in the text. $Y_i + Y_j$ is the pairwise sum of GDP. For OECD specifications, D denotes a binary variable taking value 1 for pairs of countries both in the OECD. In non-OECD specifications, D denotes a binary variable taking value 1 for pairs of countries both outside of the OECD. Trade T is measured in 2000Q1 for the early period, and in 2008Q4 for the later one. Financial linkages ϕ are measured in 2000Q1 for the early period, and in 2008Q4 for the later one. Columns (ii), (iv) and (vi) use measures of $\rho_{i,j}$ corrected for changes in variance. Standard errors are clustered by country. *** (**, *) denote significance at the 1% (5%, 10%) confidence level.

Table 5: Changes in Cycles Synchronization and Pre-Crisis Regressors

	Whole Sample	Corr.	OECD	OECD Corr	Non OECD	Non OECD Corr
T	-0.746^{***} (0.271)	-0.424^{*} (0.248)	-0.025 (0.732)	0.350 (0.775)	-0.949^{***} (0.263)	-0.591^{**} (0.238)
$T \cdot D$			-0.699 (0.798)	-0.689 (0.815)	5.888^{***} (2.088)	4.861^{***} (1.674)
ϕ	0.226 (0.209)	0.633^{***} (0.187)	0.494^{*} (0.261)	0.981^{***} (0.241)	0.320 (0.211)	0.713^{***} (0.189)
$\phi \cdot D$			-0.399 (0.255)	-0.539^{*} (0.272)	-0.565 (5.796)	-0.332 (4.458)
$Y_i + Y_j$	$-6.03 \cdot 10^{-9}$ ($6.95 \cdot 10^{-9}$)	$-2.02 \cdot 10^{-8***}$ ($7.26 \cdot 10^{-9}$)	$-7.71 \cdot 10^{-9}$ ($7.11 \cdot 10^{-9}$)	$-2.21 \cdot 10^{-8***}$ ($7.36 \cdot 10^{-9}$)	$-6.53 \cdot 10^{-9}$ ($6.96 \cdot 10^{-9}$)	$-2.07 \cdot 10^{-8***}$ ($7.27 \cdot 10^{-9}$)
R^2	0.007	0.012	0.013	0.024	0.019	0.024
$Obs.$	701	701	701	701	701	701

Notes: The left-hand side is the change in $\rho_{i,j}$ over the two periods 2000M1-2004M12 and 2004M5-2009M4. The variables T and ϕ are defined in the text. $Y_i + Y_j$ is the pairwise sum of GDP. For OECD specifications, D denotes a binary variable taking value 1 for pairs of countries both in the OECD. In non-OECD specifications, D denotes a binary variable taking value 1 for pairs of countries both outside of the OECD. Trade T is measured in 2000Q1, Financial linkages ϕ are measured in 2000Q1. Columns (ii), (iv) and (vi) use measures of $\rho_{i,j}$ corrected for changes in variance. Standard errors are clustered by country. *** (**, *) denote significance at the 1% (5%, 10%) confidence level.

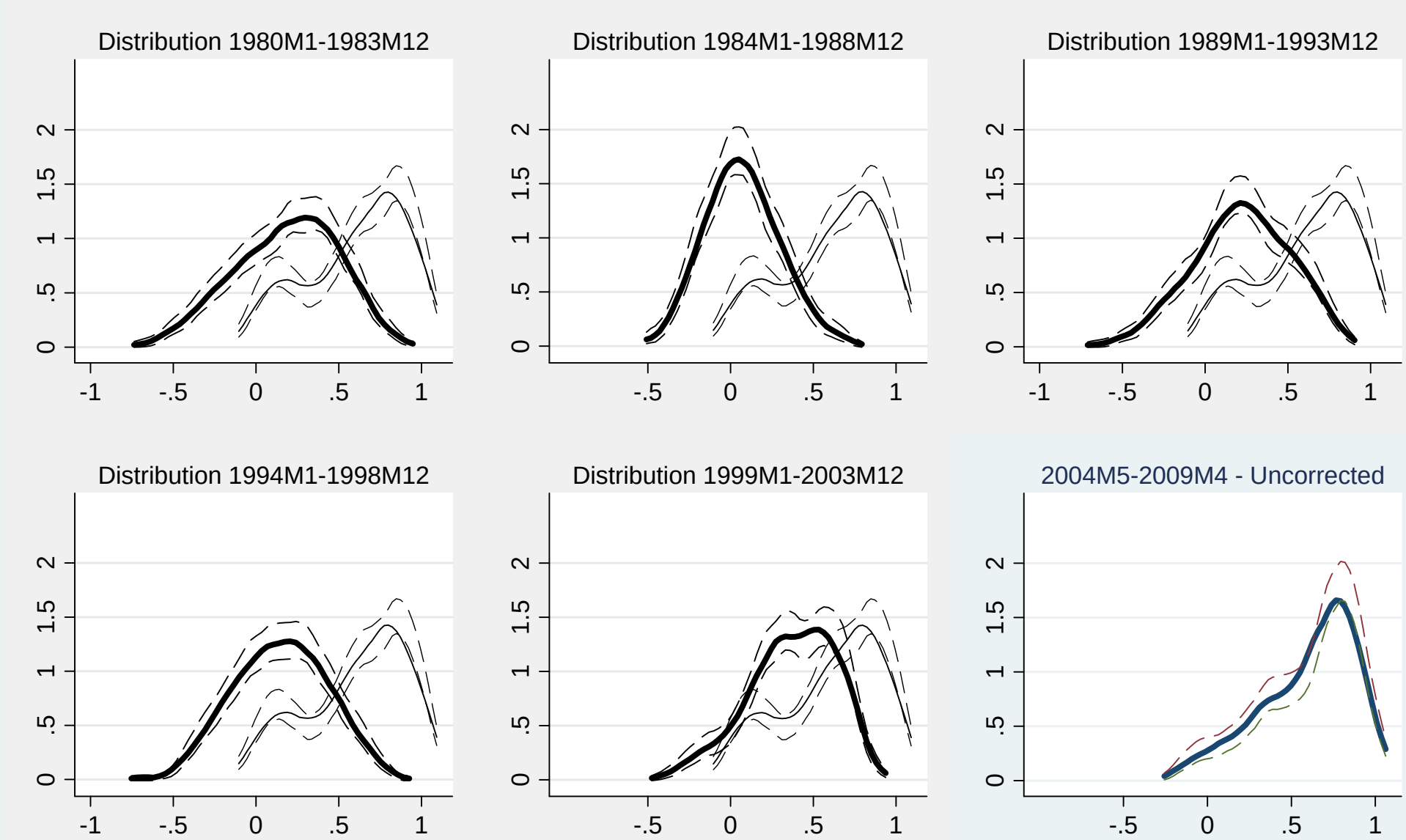

Figure 1: Twenty Four Countries - Distribution since 1980 (NSA)

The figure plots in thick plain lines the kernel estimates of the cross sectional distribution of correlation since 1980 for 24 countries and over non-overlapping 5-year sub-periods. Dotted lines represent 90% confidence intervals. Each panel also plots in thin plain lines the distribution of correlations estimated over 2004M5-2009M4, holding volatility at its 1999M1-2003M12 level. The final panel plots the distribution of correlations estimated over 2004M5-2009M4 without volatility correction

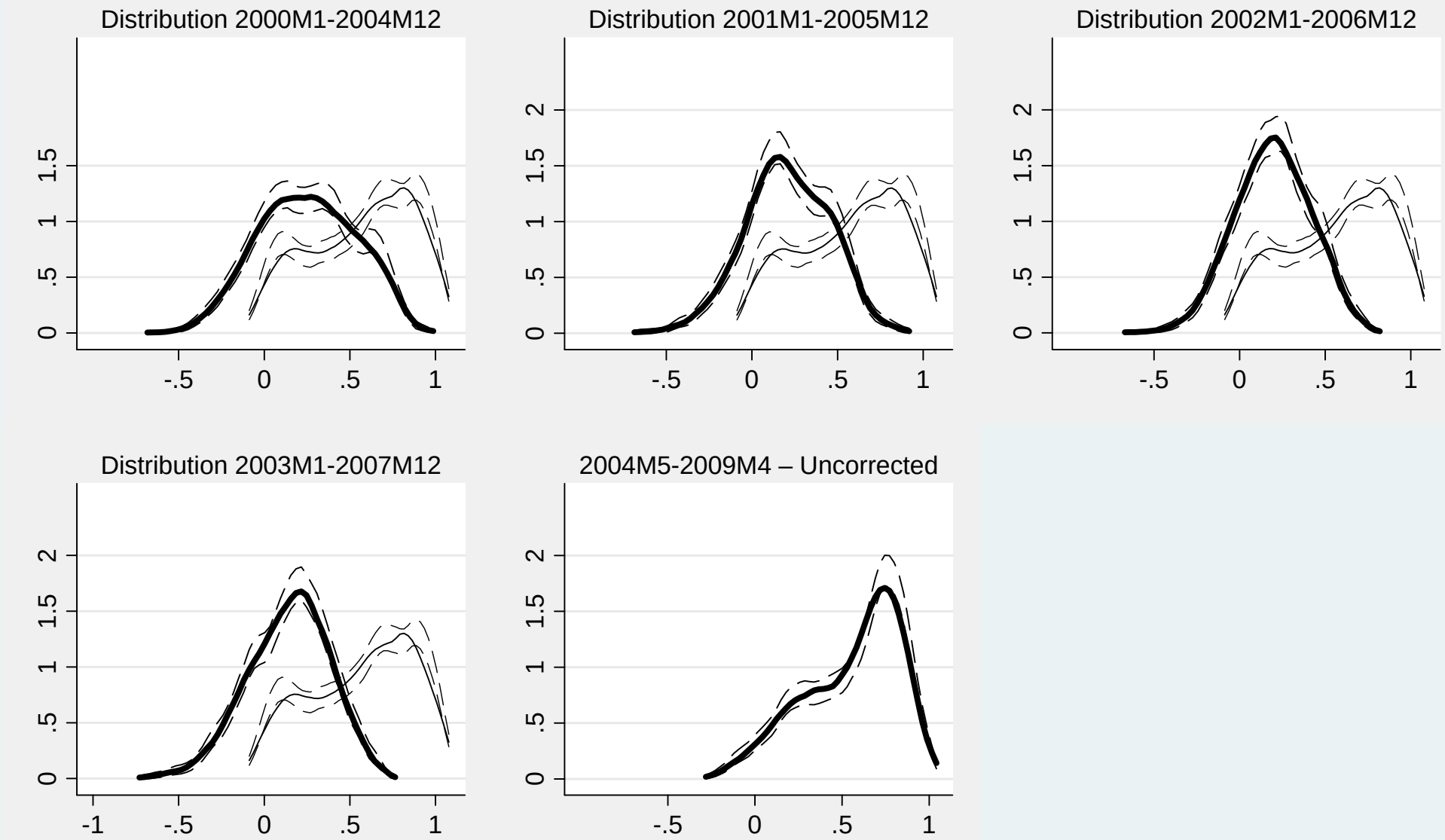

Figure 2: Thirty Nine Countries - Distribution since 2000 (NSA)

The figure plots in thick plain lines the kernel estimates of the distribution of correlation since 2000 for 39 countries and over various sub-periods. Dotted lines represent 90% confidence intervals. Each panel also plots in thin plain lines the distribution estimates corresponding to the 2004M5-2009M4 period, holding volatility at its 1999M1-2003M12 level. The final panel plots the distribution of correlations estimated over 2004M5-2009M4 without volatility correction

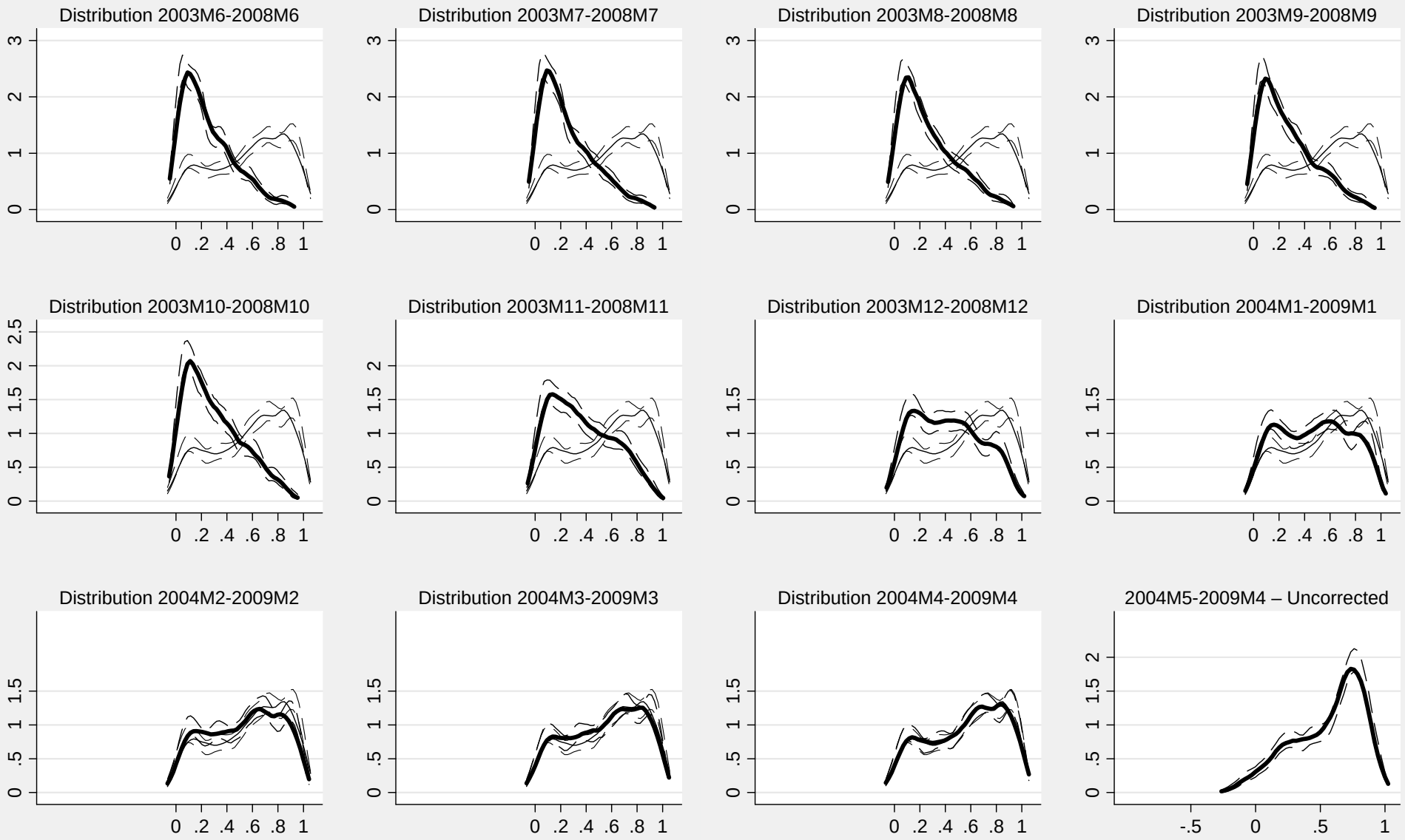

Figure 3: Thirty Nine Countries - Month by Month (NSA)

The figure plots in thick plain lines kernel estimates of the cross-sectional distribution of correlations since 2003 for 39 countries over overlapping 5-year periods. Each cross-section is estimated using 2003M6 - 2008M6 volatility levels. Dotted lines represent 90% confidence intervals. Each panel also plots in thin plain lines the distribution estimates based on 2004M5-2009M4 period, holding volatility at its 2003M6-2008M6 level. The final panel plots the distribution of correlations estimated over 2004M5-2009M4 without volatility correction

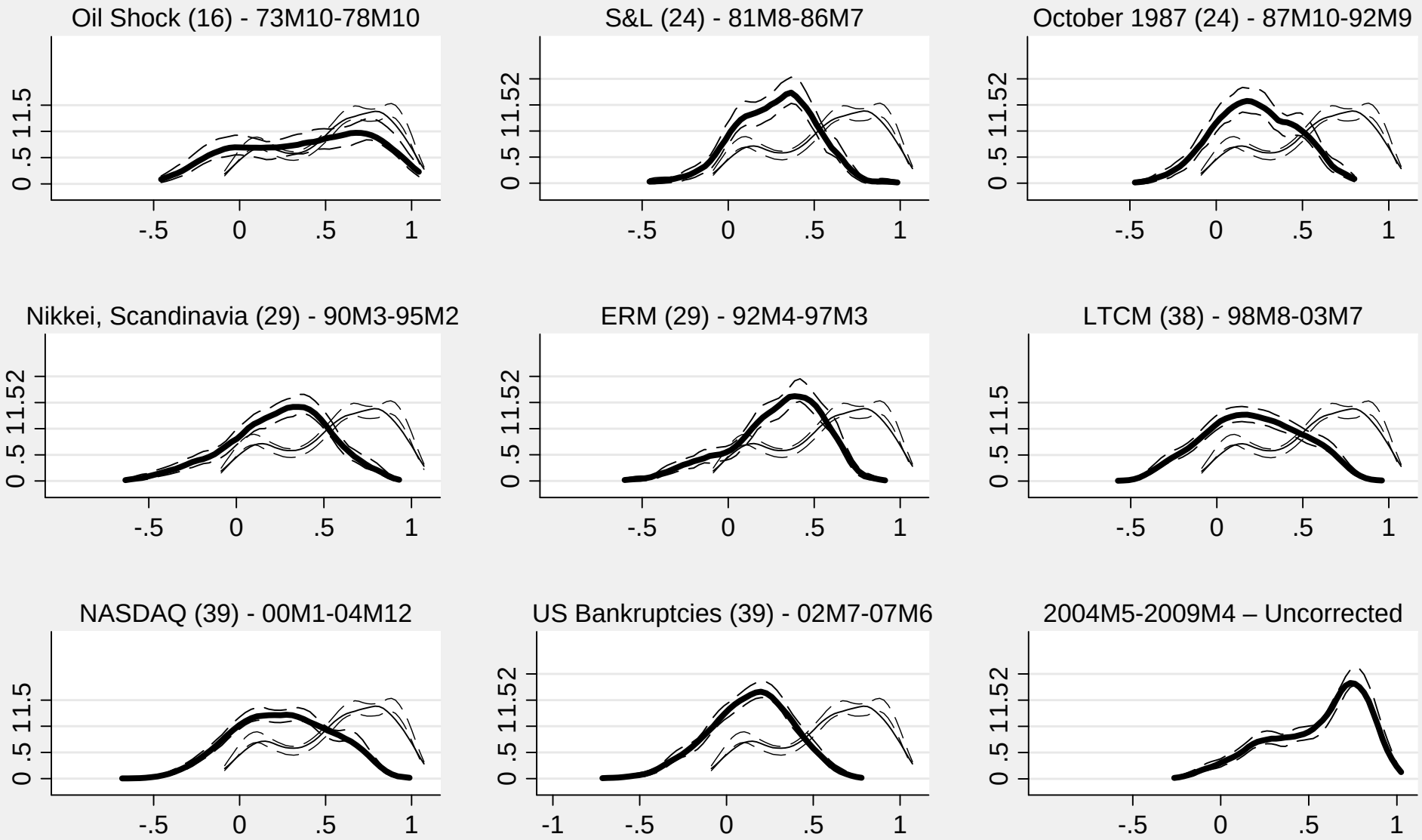

Figure 4: Alternatives (NSA)

The figure plots in thick plain lines the distribution estimates of correlations immediately after eight alternative global shocks. Numbers between parentheses represent the number of countries used in each sample. Dotted lines represent 90% confidence intervals. Each panel also plots in thin plain lines the distribution estimates corresponding to the 2004M5-2009M4 period, holding volatility at its 2003M1-2007M12 level. The final panel plots the distribution of correlations estimated over 2004M5-2009M4 without volatility correction

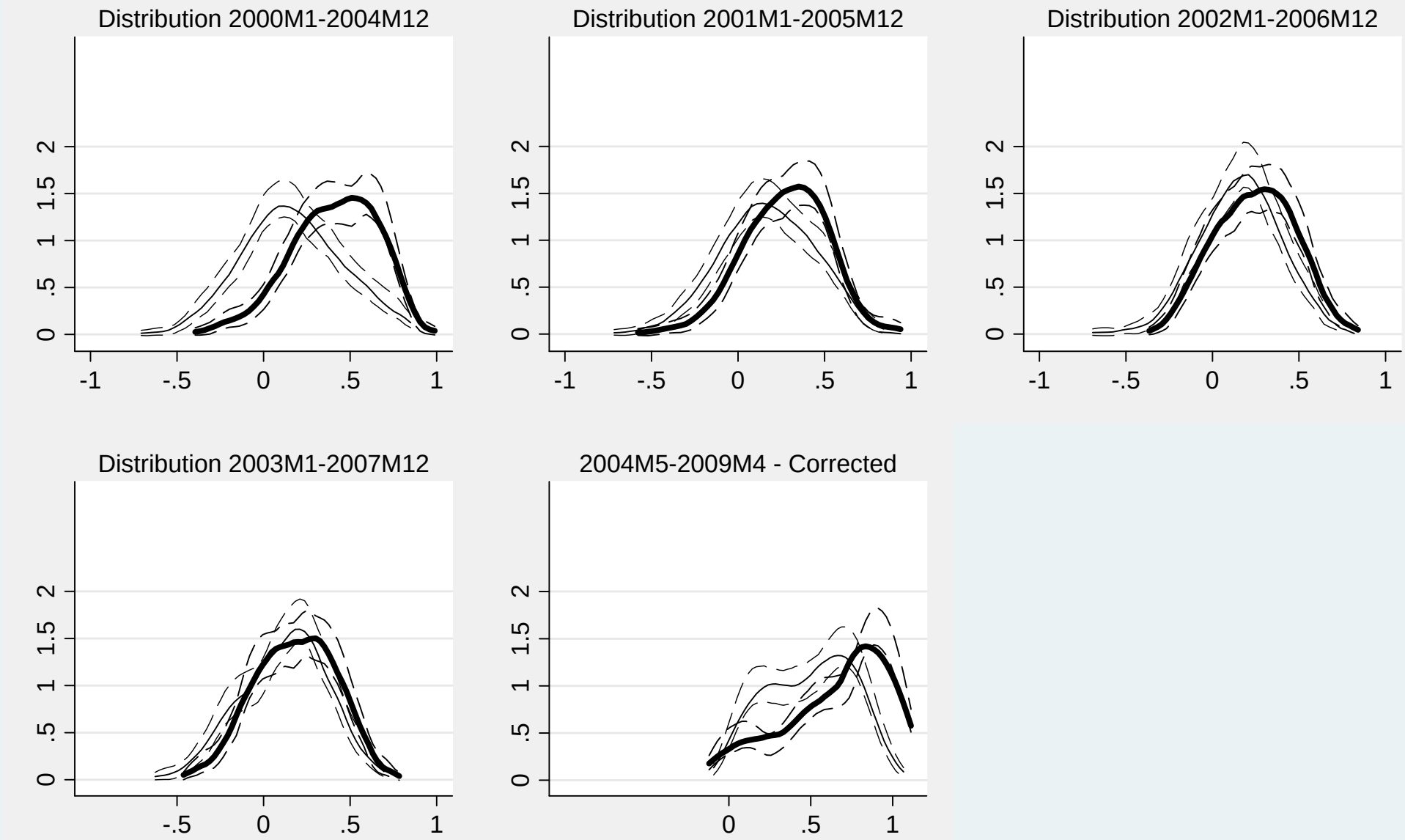

Figure 5: (19) OECD vs. (20) non-OECD samples - Distribution since 2000 (NSA)

The figure plots the distribution estimates of correlations for 29 countries since 2000, for overlapping 5-year periods.
The estimates correspond to a sample of 19 OECD countries (thick plain lines), and 20 non-OECD countries (thin plain lines).
Dotted lines represent 90% confidence intervals. The final panel holds volatility constant at its 1999M1-2003M12 level